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Technical Memorandum

Prepared for: City of Sunnyvale, Sunnyvale, CA

Project Title: Sunnyvale Strategic Infrastructure Plan for the WPCP

Project No: 135083

Technical Memorandum

Subject: Solids Loads

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To: Lorrie B. Gervin, P.E., City of Sunnyvale

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1. EXECUTIVE SUMMARY

Historical plant data (2003 – 2007) including influent flows and loads, biosolids report data and other operational data relating to solids at the City of Sunnyvale (City) Water Pollution Control Plant (WPCP) were provided by the City for the solids loads analysis. The objective of the analysis was to understand the current solids loading in the WPCP and to determine the expected future solids loads for use in planning efforts. The results of the analysis are summarized in Tables ES-1 and ES-2.

Table ES-1 has a summary of the digester solids loads that are projected in 2035.

Table ES-1. 2035 Solids Loads to Digesters

Solids Source	Average Annual Solids Load to Digesters (lb/day)
A. Primary Clarifier Solids	13,200
B. DAFT Float	13,000
A + B (Primary Clarifier Solids + DAFT Float)	26,200

Table ES-2 has a summary of the solids loads to dewatering that are projected in 2035.

Table ES-2. 2035 Solids Loads to Dewatering

Solids Source	Average Annual Solids Load to Dewatering (lb/day)
A. Primary Clarifier Solids (from digestion)	5,350
B. Primary Clarifier Solids + DAFT Float (from digestion)	15,600
C. Pond Dredgings per EOA Recommendation	28,000
B + C (All solids to dewatering)	43,600

The conclusions from the analysis are summarized here:

- There is a discrepancy in primary clarifier sludge removal calculated from plant data versus digester loadings reported in the biosolids worksheets. These worksheets report a load of approximately 10,000 lb/day of primary sludge is being collected. This is a reasonable number for a 15 mgd plant.
- The DAFT float has an average algae load of 10,000 lb/day. If all algae is sent to the digestion, the average load to the digesters would approximately double.
- Additional solids, beyond the primary sludge and DAFT float, are still accumulating on the pond bottom. Data suggest that it is several thousand pounds per day even with the DAFT float removed.
- Removal of pond inventory will be a major factor in sizing solid processing facilities.

2. INTRODUCTION

This Technical Memorandum (TM) describes the existing solids treatment process and solids loads at the WPCP. Based on the existing loading and the TM on future influent flows and loads, predictions for the future solids production can be made. These predictions will be used in subsequent tasks as a part of the Strategic Infrastructure Plan for the WPCP.

2.1 Background

A solids flow diagram for the WPCP is shown in Figure 1.

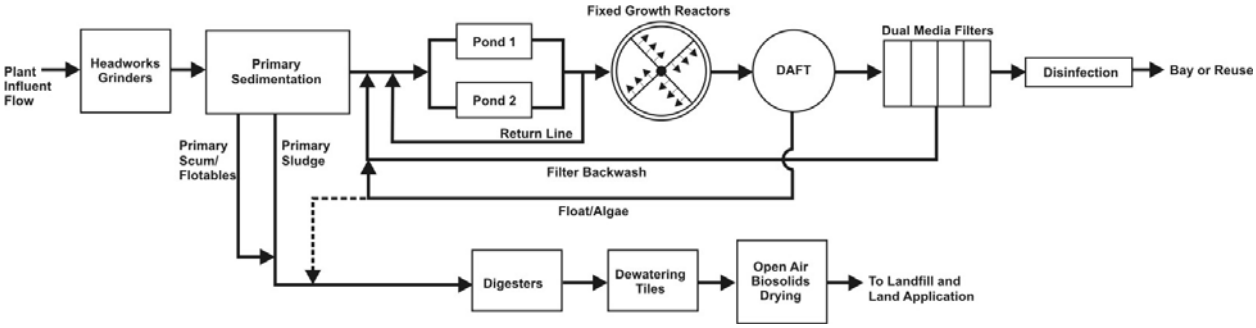

Figure 1. Solids Flow Diagram for Sunnyvale WPCP

The two main solids flow paths are from the primary clarifiers and the DAFT float. The solids collected from the primary clarifiers are sent to Digesters 1-3 for anaerobic digestion. The float from the DAFT is largely composed of algae from the oxidation ponds. A portion of this float has been sent to the digesters occasionally over the years but current operation has the DAFT float solids returning to the ponds. After Digesters 1-3, solids are sent to Digester 4 and decanted before dewatering. Digested solids are dewatered on gravity drainage tiles to 15-20% solids. After dewatering, the solids are spread out over a drying area and are solar dried to 50-70% solids.

Loadings to the plant are expected to increase due to population growth. Other expected solids loads for processing include the full algae float as well as future dredged solids from the oxidation ponds.

3. ANALYSIS OF HISTORICAL DATA

Operations data from 2004-2007 was examined to further understand plant operation and to confirm biosolids production quantities. This allows for more accurate solids projections.

3.1 Primary Solids

Primary influent and effluent TSS concentrations were examined to determine the solids removal efficiency of the primary clarifiers and predict solids loads based on influent loads. TSS data was gathered once a day approximately three days a week. The removal efficiencies calculated from this data set are shown in Figure 2.

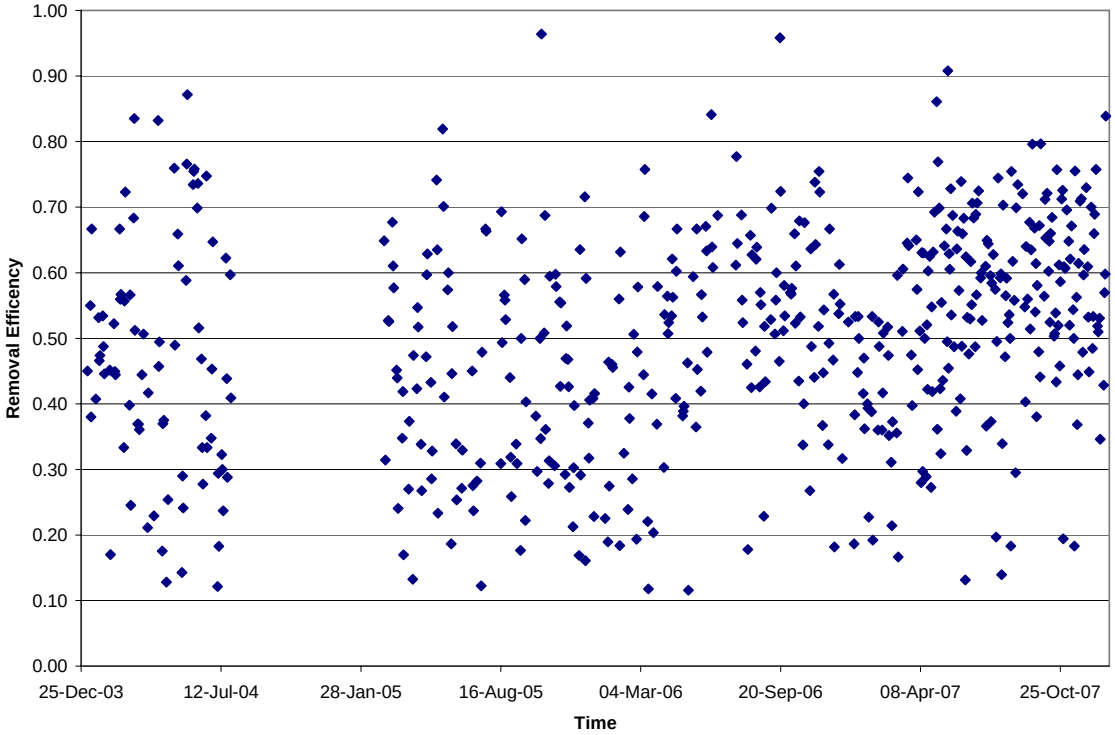

Figure 2. Primary clarifier TSS Removal Efficiency for 2004-2007

The values in Figure 2 show a range between 11-96 percent with most points between 30-70 percent. The annual average removal efficiency was calculated for each year and is summarized in Table 1.

Table 1. Annual Average Primary Clarifier TSS Removal Efficiency

Year	TSS Removal Efficiency (%)
2004	45
2005	41
2006	47
2007	54

The removal efficiencies based on this available data show less than typical performance. Typical primary removal efficiencies are around 60 percent. Using this data, the predicted solids flow to the digesters is much lower than recorded in the plant. The primary clarifiers are likely performing much better than predicted here. The low predicted removal efficiencies could be due to the frequency of the data collection, only a few samples are collected each week. The recorded values for primary solids going to the digesters is approximately 10,000 lbs/day which supports an average removal efficiency of 60 percent. It is reasonable to assume the amount of solids reported in the biosolids summary reports is accurate. Additionally there is no

historical data characterizing the primary scum or floatables that are sent to the digesters but the solids values in the biosolids summary reports account for this load.

3.2 Algae Production

A portion of algae produced in the oxidation ponds has been sent to the digesters occasionally in the past with the remainder being returned to the ponds. Lack of knowledge about the flow and algae concentration in this return line or about the amount of algae that settles in the ponds makes it difficult to determine the algae production on a mass balance basis. However, determining a value for algae yield in the ponds for an empirical calculation is also problematic. Many factors such as sunlight availability, temperature and cloud cover effect the value of the yield. For the purposes of this TM the pond effluent TSS was assumed to contain 90 percent algae and be a good indicator of algae produced in the ponds.

The average annual pond effluent TSS concentration is summarized in Table 2. The calculated loadings are based on an average annual plant influent flow of 15.1 mgd.

Table 2. Annual Average Pond Effluent TSS Values

Year	TSS Concentration (mg/L)	TSS Load (lb/day)
2004	122	15,400
2005	130	16,400
2006	111	14,000
2007	114	14,400
4 –yr Average	119	15,000

The TSS concentration during this time period ranges from 26 - 298 mg/L. Therefore, the TSS load ranges from 3,000 – 37,500 lb/day. The 4-yr average TSS load from the ponds is 15,000 lb/day of which 90% is algae, making the average algae load approximately 13,500 lb/day. The range of algae load is 2,900 – 33,750 lb/day.

The pond effluent flows to the fixed growth reactors before algae solids are separated in the DAFTs. It is the DAFT float that has been sent to the digesters. By examining the DAFT influent and effluent values of TSS the removal efficiency in the DAFTs can be determined. The removal efficiencies for three years worth of data are summarized in Table 3.

Table 3. Annual Average DAFT TSS Removal Efficiency (%)

Year	DAFT 1	DAFT 2	DAFT 3
2005	83	83	84
2006	78	79	82
2007	65	66	71
3-yr Average	76	76	79
Overall Average	77		

The average removal efficiency of the DAFTs is 77 percent, as shown in Table 3. Based on this removal efficiency and the average pond effluent algae load, the average load in the DAFT float is 10,400 lb/day with a range of 2,300 – 29,000 lb/day.

3.3 Digested Solids

A measure of digester performance is volatile solids (VS) reduction. The percentage of VS reduction in the Sunnyvale digesters is shown in Figure 3. The solids retention time (SRT) assuming primary sludge only is also plotted in Figure 3.

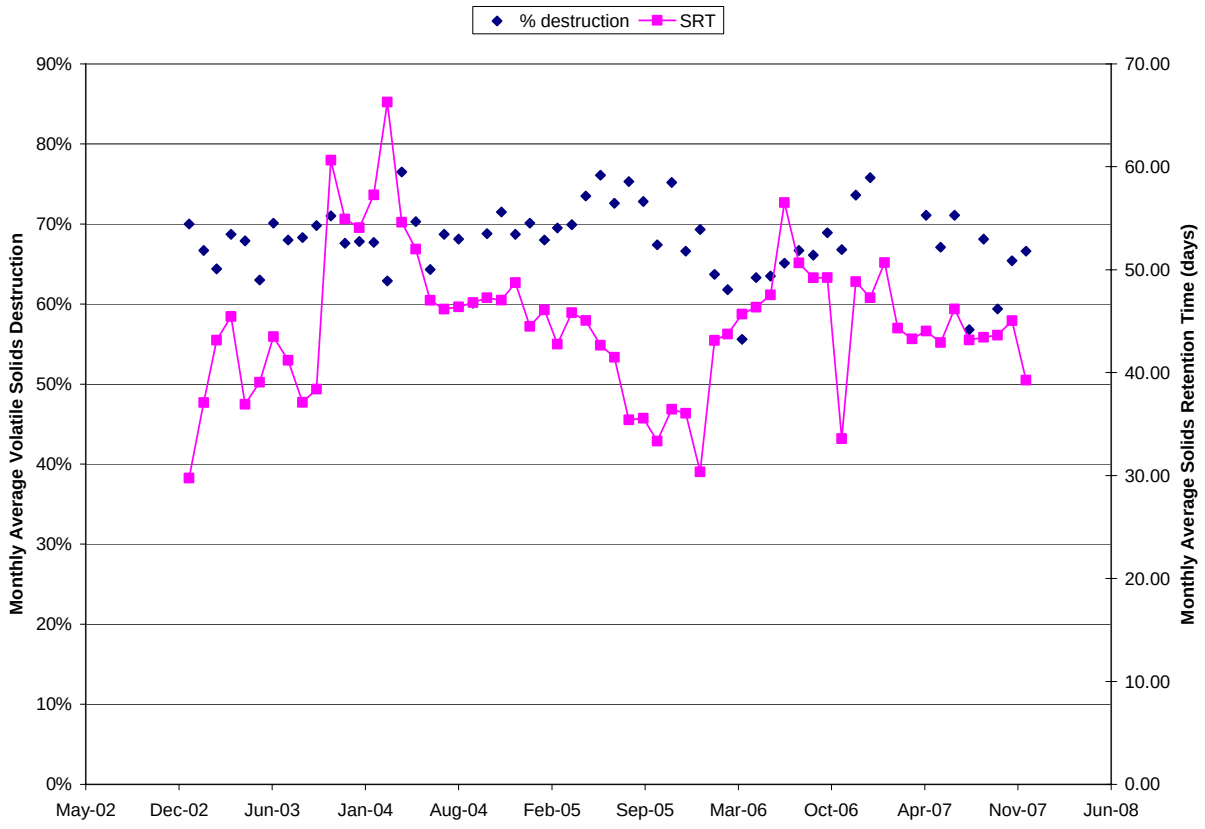

Figure 3. Volatile Solids Percent Reduction and SRT in the Anaerobic Digesters for 2003 - 2007

The range of typical values for well performing digesters when digesting primary sludge with an SRT above 30 days is over 60 percent. The values shown in Figure 3 vary from 56 – 77 percent with an average of 68 percent. Only a few points fall below 60 percent. The monthly average SRT during this time period ranges between 30 – 66 days. This value was calculated using the primary sludge flow rate to the digesters assuming Digesters 1-3 are in service at all times. This does not include the algae flow which on average would reduce the SRT by approximately 15 percent. The VS reduction values show good performance from the digesters. These high levels of VS reduction are expected since these digesters receive most solids loads in the form of primary sludge which is a very digestible form of solids.

The biosolids quantities that are hauled off site after drying are summarized in Table 4.

Table 4. Biosolids Hauling Quantities		
Year	Land Application (dry tons)	Biosolids Monofill (dry tons)
2003	594	256
2004	1279	31
2005	649	---
2006	539	---
2007	318	734

Every year some amount of biosoilds are retained in on-site storage ranging from 159 – 612 dry tons. In 2003 over 600 dry tons were retained but in 2004 and 2007 only 174 and 159 dry tons were stored respectively.

3.4 Pond Solids Accumulation

The oxidation ponds have been in service since 1968. For the first 26 years of pond operation most or all of the digested primary sludge and all algae was deposited in the ponds. In 1994, after the current dewatering system was constructed, the primary digested sludge was no longer sent to the ponds. Most of the algae float has continued to return to the ponds with only a portion occasionally being routed to the digesters.

This 40 years of pond solids accumulation has led to concerns regarding the future capacity of these ponds. In November 2004 EOA, Inc. submitted the *Pond Cleaning Pilot Project Report* (Report) which summarizes the finding from the pond cleaning pilot project as well as makes recommendations for a full scale effort. During this pilot study 600 tons of solids were removed from the ponds. In the report EOA estimates the current rate of accumulation in the ponds at 900 tons/yr with approximately 73,000 dry tons as the accumulated inventory in 2004.

4. PROJECTED BIOSOLIDS QUANTITIES

4.1 Future Solids Production

As part of the Sunnyvale SIP Brown and Caldwell submitted *Influent Flows and Loads Technical Memorandum* (Flows and Loads TM) on [date]. According to the analysis and projections in the Flows and Loads TM the average annual flow to the WPCP is expect to rise from 15.1 mgd to 18.6 mgd by 2035. This is a 23 percent increase in flow. The average dry weather TSS load is expect to increase from 18,000 lb/day to 22,000 lb/day by 2035, a 22 percent increase. Based on the expected increase in flows and loads the solids production quantities can also be increased by 23 percent.

The flow and TSS load peaking factors in the Flows and Loads TM are high as compared to other similarly sized treatment plants. Peaking factors will only apply to primary sludge production due to the high residence time in the ponds.

4.2 Future Algae Production

The algae production will increase as the flow and loading to the plant increases. Therefore a 23% increase by 2035 is expected. The algae load in the DAFT float will range from 2,800 – 36,000 lb/day with an average of 13,000 lb/day. The DAFT float is the algae load that would be sent to the digesters should algae digestion be the desired operating mode. There is additional algae solids that remain in the bottom of the ponds due to settling.

4.3 Expected Dredging Quantities

The solids removed from the ponds will dominate the solids handling needs in the future. The recommendation in the Report is to conduct a partial restoration where approximately 36% of accumulated solids are removed. This restoration will remove around 26,000 dry tons based on the 2004 inventory. As many as 47,000 dry tons would remain in the ponds. There are three alternatives for execution of this restoration that are considered in the Report. The alternative that is selected will impact the technological and operational decisions made about the future plant. The processing rate is based on the assumptions that the feed solids to the belt press will have approximately 4 percent total solids and that the dewatered product will be 20 – 25 percent total solids. The three alternatives are summarized in Table 5.

Table 5. Alternatives to Remove 36% of the 2004 Pond Solids Inventory

	Alternative 1	Alternative 2	Alternative 3
Processing rate (ton/day)	10	20	50
Duration (years)	10.4	5.2	1.5
Cost range[1] (million dollars)	9.4 – 12.2	7.5 – 10.3	6.2 – 9.0

[1]Cost range depends on disposal method, offsite handling and reuse will be more costly than disposal at City Monofill. The range is a present value cost that includes mobilization/demobilization, dredging/dewatering and hauling and disposal/reuse.

The recommendation in the Report is Alternative 2 due to siting issues and other uncertainties associated with Alternative 3.

4.4 Future Solids Loads

Table 6 has a summary of the digester solids loads that are projected in 2035.

Table 6. 2035 Solids Loads to Digesters

Solids Source	Average Annual Solids Load to Digesters (lb/day)
A. Primary Clarifier Solids	13,200
B. DAFT Float	13,000
A + B (Primary Clarifier Solids + DAFT Float)	26,200

Table 7 has a summary of the solids loads to dewatering that are projected in 2035.

Table 7. 2035 Solids Loads to Dewatering	
Solids Source	Average Annual Solids Load to Dewatering (lb/day)
A. Primary Clarifier Solids (from digestion)	5,350
B. Primary Clarifier Solids + DAFT Float (from digestion)	15,600
C. Pond Dredgings per EOA Recommendation	28,000
B + C (All solids to dewatering)	43,600

The solids loading to dewatering depends on the VS content of the influent digester flow as well as the VS solids reduction. The primary clarifier solids at the WPCP range from 85 – 89 percent VS. For these calculations, 85 percent VS content was assumed with 70 percent VS reduction. When the algae float is added to the digesters the SRT is lowered. This decreases the amount of VS reduction that can take place in the digesters. Based on historical data and for the purposes of these calculations, the algae float was assumed to have 85 percent solids. The VS reduction, with the primary sludge and algae float combined in the digesters, was assumed to be 60 percent for the primary sludge VS and 35 percent for the algae float VS. The pond dredging solids load is based on the recommendation from EOA of 20 tons/day, 5 days per week. This is an average annual solids load of approximately 14 tons/day.

5. CONCLUSIONS

The following conclusions can be made from the data:

- There is a discrepancy in primary clarifier sludge removal calculated from plant data versus digester loadings reported in the biosolids worksheets. These worksheets report a load of approximately 10,000 lb/day of primary sludge is being collected. This is a reasonable number for a 15 mgd plant.
- The DAFT float has an average algae load of 10,000 lb/day. If all algae is sent to the digestion, the average load to the digesters would approximately double.
- Additional solids, beyond the primary sludge and DAFT float, are still accumulating on the pond bottom. Data suggest that it is several thousand pounds per day even with the DAFT float removed.
- Removal of pond inventory will be a major factor in sizing solid processing facilities.